

ASME B31.3 Process Piping

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Layout and Support - 1

Piping Development Process

1. Establish applicable system standard(s)
2. Establish design conditions
3. Make overall piping material decisions
 - Pressure Class
 - Reliability
 - Materials of construction
4. Fine tune piping material decisions
 - Materials
 - Determine wall thicknesses
 - Valves
5. Establish preliminary piping system layout & support configuration
6. Perform flexibility analysis
7. Finalize layout and bill of materials
8. Fabricate and install
9. Examine and test

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7. Layout and Support

- General Considerations
- Support Spacing
- Support Locations
- Support Elements

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The Material in This Section is
Addressed by B31.3 in:

Chapter II - Design

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General Considerations

- Access for operation (valves)
- Access for maintenance of in-line devices
 - instrumentation
 - Traps
 - strainers, etc.
- Avoiding interference with other activities
 - Removing heat exchanger bundles
 - Clearance for pump maintenance, etc.
- Appearance

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General Considerations

- Drainage (slope) requirements
- Pressure drop
- Cost of piping, including maximizing use of existing supports
- Avoiding interference with other piping
 - Clearance for application of insulation
 - Clearance for piping displacement, etc.
- Provisions for future additions

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Support Spacing

Loads to consider

- Dead Weight
 - Pipe
 - Insulation
 - Valves, specialty items and instruments
- Live loads
 - Pipe contents
 - Ice, snow
 - People



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Support Spacing

Two principal sources:

1. Recognized codes & standards
 - ASME B31.1
 - MSS SP-69: Pipe Hangers and Supports – Selection and Application
2. Owner or designer calculated values

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Support Spacing

NPS	MSS SP-69		Typical Calculated	
	<u>ft</u>	<u>m</u>	<u>ft</u>	<u>m</u>
1	7	2.1	14	4.3
2	10	3.0	20	6.1
4	14	4.3	26	7.9
6	17	5.2	30	9.1
8	19	5.8	32	9.8
10	22	6.1	34	10.4
12	23	7.0	36	11.0

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Support Spacing

Usually based on simplifying assumptions

- Combination of pipe material and wall thickness used in the facility that gives the shortest spans
- Contents specific gravity, usually 1.0
- Typical insulation thickness and density
- Person walking on pipe for larger sizes

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Support Spacing

Two Models Frequently Used

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Support Spacing

S_L = stresses caused by bending moment and pressure
 $= M/Z + PD/4t$
 $= (wL^2 + 2HL) / (8Z) + PD/4t$

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Support Spacing

$$S_L = (wL^2 + 2HL) / (8Z) + PD/4t$$

Where

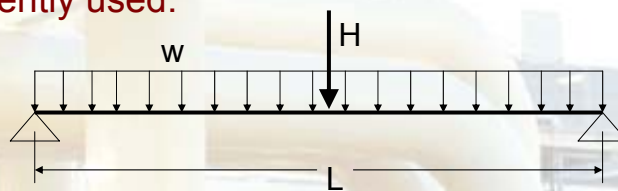
- D = pipe outside diameter
- H = concentrated load (people)
- L = trial length for support spacing
- M = bending moment
- P = design pressure
- t = pipe wall thickness nominal wall thickness less mechanical, corrosion and erosion allowances
- w = uniform load due to pipe, contents & insulation
- Z = pipe section modulus

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Support Spacing

Some designers limit support spacing using an arbitrary deflection criterion. 0.5 in. (12 mm) is frequently used.



$$\Delta_{\max} = (5wL^4 / 384EI) + (HL^3 / 48EI)$$

Where

- E = pipe material elastic modulus
- I = pipe moment of inertia

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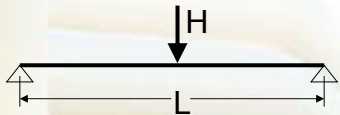
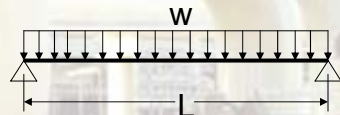
Layout and Support - 14

Support Spacing

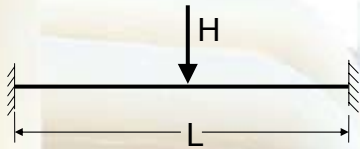
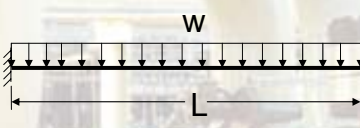
- This calculation method is only applicable to straight pipe with more-or-less uniformly spaced supports.
- Using the simply supported beam model versus the fixed beam supported model adds some conservatism to the calculation.
- Other models that can be used are shown on succeeding slides.

Support Spacing

Assuming simply supported ends

Concentrated load		$M = HL/4$ $\Delta_{\max} = HL^3/48EI$
Uniform load		$M = wL^2/8$ $\Delta_{\max} = 5wL^4/384EI$

Support Spacing Assuming Fixed ends

Concentrated load		$M = HL/8$ $\Delta_{\max} = \frac{HL^3}{192EI}$
Uniform load		$M = wL^2/12$ $\Delta_{\max} = \frac{wL^4}{384EI}$

Support Locations

Supports must be located such that $S_L \leq S_h$.
Following these rules of thumb will help:

- Piping running up the side of vessels should be supported from the vessel, generally near the top of the run.
- Locate concentrated loads (e.g. valves) near supports.
- Use rigid supports (i.e. not spring supports) at safety valves.

Support Locations

Following these rules of thumb will help when doing the flexibility analysis:

- As much as possible, attach supports to straight pipe rather than elbows or other fittings.
- Provide space for adding loops to piping near load sensitive equipment, e.g. in pump suction lines.
- Consider the need to add friction reducing slides between the piping and support steel.

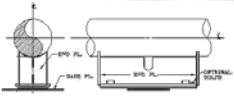
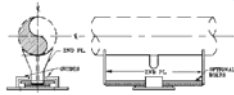
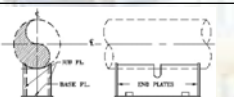
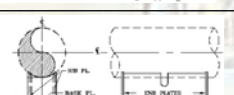
Support Locations

Following these rules of thumb will help operation and maintenance:

- Attach supports to pipe, not valves, flanges or instruments.
- Provide supports near instruments, and other devices that are likely to be removed for maintenance.
- Support piping such that spools to be removed for equipment maintenance can be removed without adding temporary supports.
- Minimize the use of spring hangers.

Support Elements

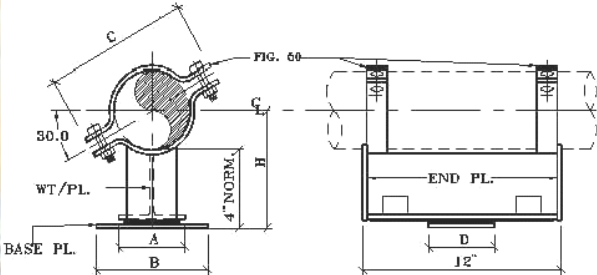
Support elements are classified by the degree of restraint provided to the piping

Simple Support	Only provides vertical restraint	
Guide	Restrains lateral movement (and sometimes vertical movement as well)	
Longitudinal Pipe Restraint	Restrains axial movement (and sometimes vertical movement as well)	
Anchor	Restrains movement in all directions (welded to support steel)	

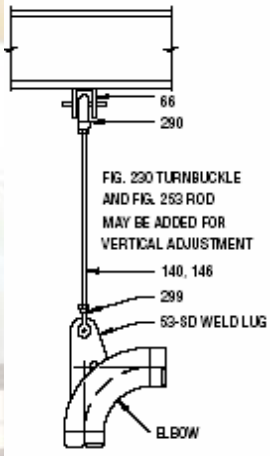
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Simple Support



(from Piping Technology & Products)

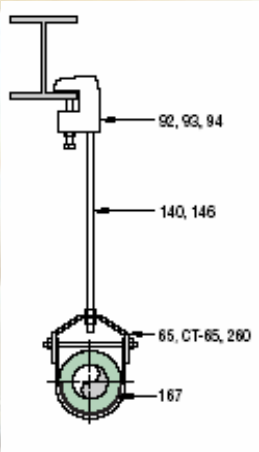
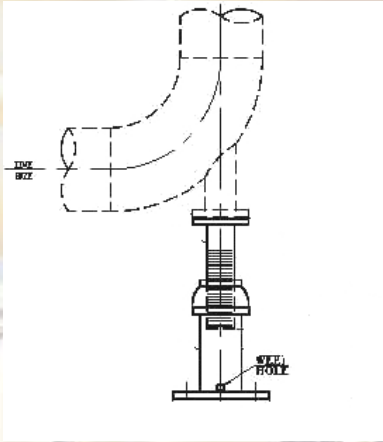


(from Anvil International)

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Simple Support



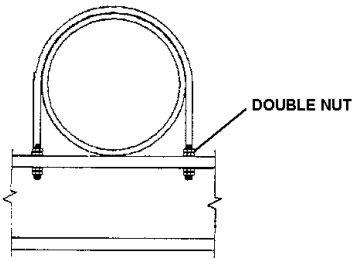


(from Piping Technology & Products)

(from Anvil International)

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Guide



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Spring Hangers

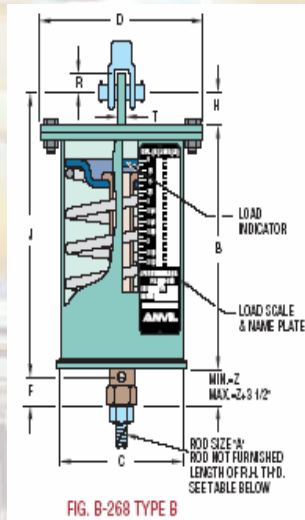
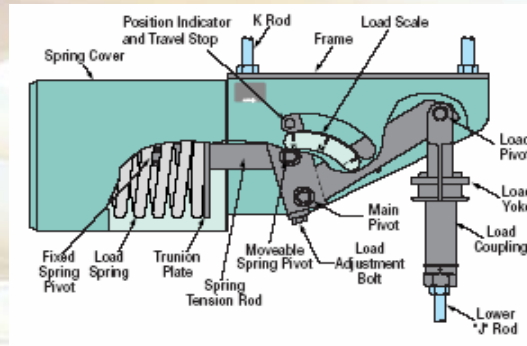


FIG. B-268 TYPE B



(from Anvil International)

Constant Type**Variable Type****BECHT** ENGINEERING COMPANY, INC.

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Special Purpose Supports



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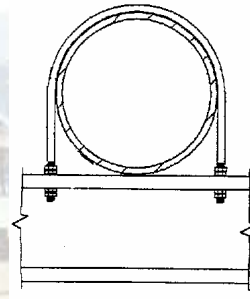
Sway strut – used to prevent horizontal movement.**Hydraulic snubber** – used to prevent sudden horizontal movement but allow slowly applied displacement.**BECHT** ENGINEERING COMPANY, INC.

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Support Element Selection

Resting pipe directly on structural steel should be avoided when:

- Carbon steel pipe is in a wet environment and failure by corrosion is not tolerable
- Stainless steel pipe would be in contact with galvanized steel and failure by liquid metal embrittlement during a fire is not tolerable



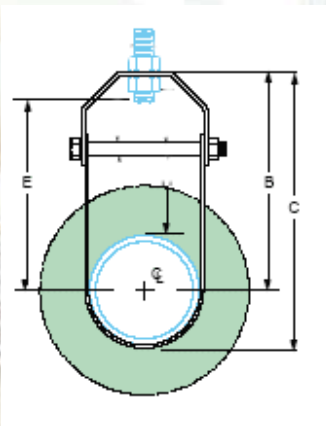
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Support Element Selection

Support elements on outdoor insulated piping should penetrate the insulation on the bottom of the pipe.

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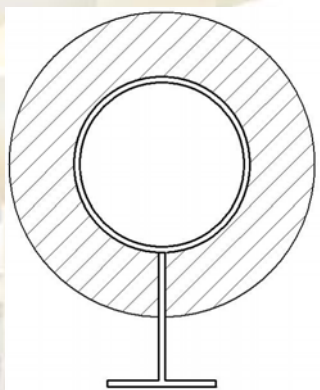


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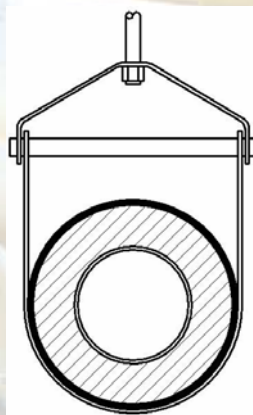
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Support Element Selection

Some solutions:



Use pipe shoes



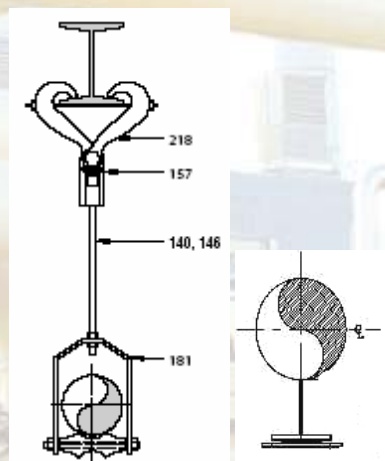
Support outside the insulation

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Support Element Selection

In aggressive external corrosion environments, support should be via structural steel under the pipe rather than hanger rods with multiple threaded connections that may fail in a few years.



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